Characteristics of a sampling of New York State composts

Composting and marketing of composted products is an option for managing organic residuals. Composting is an environmentally sound and energy efficient way of managing manure, yard waste, food scraps, paper residuals, and even animal mortality. However, the resulting product should be used in order for it to also be profitable. Many farms, schools and other composters have difficulty finding markets for their composts as consumers have little knowledge of compost qualities and sources.

CWMI has sampled and had analyses performed on 488 composts from 62 facilities in NYS described in table 1 and tables of all the data with means, standard deviations, minimum, maximum and median values (dry weight basis) can be found in Appendix A. An excel file with all individual points can be found at: http://hdl.handle.net/1813/48204). Sampling was performed on composts which the facility deemed mature, except in the case of the road-killed mortality composts, which were sampled over a period of time from the day they were built through 12 months. Therefore, other than the mortality compost, these samples should reflect finished composts. The characteristics of these composts are summarized in the following pages to give an idea of the quality of NYS composts based on the feedstock. We give a general description of the ranges of these characteristics within which finished compost should fall and relate the analysis of the feedstocks to these ranges. The properties that are important for different end uses of compost vary, so that, for example, use of composts in potting mixes requires different characteristics than use for erosion control. For more information on compost properties for specific uses, please see "Compost Use Guidelines and Specifications". In addition, you may consult the US Composting Council's Field Guide to Compost Use.

Table 1: Description of samples analyzed within New York State

Major Feedstock/total number of samples	Bulking Material	Composting Method	# of facilities	# of samples
Dairy Manure (124)	Silage/bedding	Turned windrow	2	6
	Straw	Turned windrow	6	28
		Passively aerated windrow system (PAWS)	1	6
	Wood/bedding	Turned windrow	6	84
Food scraps (60)	Yard waste	Turned windrow	8	24
		Fermented, then turned into piles	1	3
		PAWS	3	18
		Turned windrow and Aerated static pile (ASP)	3	9
		Varied methods	2	6
Horse manure (3)	Wood/Bedding		1	3
Mixed manure (15)	Straw/paper residuals	Turned windrow	1	15
Road-killed mortality (6)	Woodchips	Static Pile	4	6
Paper Residuals (8)	None	Turned windrow	1	8
Poultry Manure (98)	Straw	PAWS	1	5
		Turned windrow	1	6
	Wood/bedding	Turned windrow	5	87
Separated Dairy Manure (96)	Straw	Turned windrow	4	69
		PAWS	1	8
	Wood/bedding	Turned windrow	4	24
Silage (5)	Paper residuals	Turned windrow	1	5
Yard waste (73)		ASP	1	22
		Turned windrow	14	42
		PAWS	1	3

The parameters of interest in finished compost include % moisture, organic matter, nitrogen and carbon as well as carbon to nitrogen ratio (C:N), pH, salinity, bulk density, plant macro and micronutrients, and metals analysis. Other parameters of interest are water holding capacity (WHC), pathogens (fecal coliforms and/or salmonella) and %

germination and germinable weeds. Table 2 shows the mean and range of moisture, organic matter, total nitrogen (TKN) and C:N of the composts analyzed by major feedstock used in making the compost.

The moisture content of a finished compost should be between 40 and 50%. The moisture content of compost affects its bulk density, and therefore, may affect transportation. Moisture content is also relevant because it affects product handling. Compost which is dry can be dusty, while compost which is wet can be heavy and clumpy, making it difficult to apply as well as more expensive to transport. Compost made from poultry manure was the driest and that made from road-killed animals was the wettest. The analyses of compost made from mortalities included samples of "not finished" compost, when the pile was mostly woodchips. Therefore, many of the values found for this particular compost will not fall into the preferred ranges. In addition, mortality compost should only be used in low public contact areas (i.e. highway medians, farm fields) and should be at least one year old before being used.

Most growers use compost to increase the organic matter in their soil. Finished composts average between 30 and 70% organic matter. Organic matters >50% indicate an immature compost, while OM < 35% indicate that the compost is old. An OM content (dry weight basis) of 50-60% is desirable for most compost uses. Food scraps compost had the lowest mean OM followed by dairy manure that was not separated prior to composting.

Total nitrogen (TKN) includes all forms of nitrogen: organic N, ammonium N (NH_4-N), and nitrate N (NO_3-N). The means and range of these forms of N are shown in Table 3. TKN should be between 0.5 and 2.5% (dry weight basis) in finished composts. NO_3-N is generally present in only low concentrations in immature composts, although may increase as the compost matures. NH_4-N levels may be high during initial stages of the composting process, but decrease as maturity increases. Organic N is determined by subtracting the inorganic N forms, NH_4-N and NO_3-N, from total N. In stable, finished composts, most of the N should be in the organic form. While NH_4-N and NO_3-N are immediately available to plants, organic N is only slowly available, approximately 10 % per year. All of the composts below fall into the general range for TKN with most of it being organic N. The composts with higher ammonium N concentration are those composts that were made with feedstocks that contain more ammonium nitrogen.

Total organic carbon (TOC – Appendix A) is a measure of all organic carbon in the sample. Compost organic matter typically contains around 54% carbon by weight. From TOC and TKN, Carbon:Nitrogen ratio (C:N) can be calculated. C:N ratio may be used as an indicator of compost stability and N availability. Composts with high C:N ratios (> 30) will likely immobilize N if applied to soil, while those with low C:N ratios (<15) will mineralize organic N to inorganic (plant-available) N. Other than road-killed mortality compost, which has already been discussed as not considered mature, and poultry manure compost, < 15 due to the high nitrogen content of poultry manure, means for all the other composts fall within the mature range and should not cause a problem with N availability in the soil.

Table 2: Mean and range for moisture, OM, TKN and C:N ratio by major feedstock

Major Feedstock	% Moisture		% Organic matter		% TKN (total nitrogen)		C:N ratio	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Dairy Manure	58.5	31.4 – 85.5	39.4	15.8 – 92.3	1.4	0.5 – 3.3	15.1	8.6 – 25.5
Food Scraps	50.2	21.4 – 74.6	32.0	26.1 – 35.9	1.0	0.2 – 2.3	20.5	1.1 – 75.6
Horse Manure	65.7	56.5 – 75.0	58.3	54.3 – 65.6	1.6	1.2 – 1.9	20.2	18.2 – 23.8
Mixed Manure	53.0	43.3 – 71.5	-	-	-	-	16.6	10.9 – 24.2
Road-killed Mortality	73.5	66.6 – 80.1	73.3	24.4 – 88.9	1.5	0.7 – 2.4	34.5	19.7 – 52.9
Paper Residuals	52.6	44.4 – 67.0	56.6	34.1 – 100.0	2.1	1.6 – 2.7	23.4	16.0 – 43.0
Poultry Manure	31.9	14.1 – 60.7	42.2	22.2 – 57.2	2.9	0.9 – 8.3	9.8	3.1 – 18.6
Separated Dairy Manure	63.8	32.4 – 82.2	54.7	22.0 – 87.4	2.2	1.1 – 3.4	13.4	7.9 – 25.7
Silage	48.5	61.1 – 43.8	53.8	35.8 – 100.0	2.7	2.0 – 3.3	18.6	15.8 – 28.8
Yard Waste	50.3	23.9 – 67.7	52.3	20.3 – 100.0	1.6	0.2 – 4.4	20.0	12.4 – 43.7

Table 3: Mean and range for Organic N, Nitrate-N and Ammonium-N by major feedstock

Major Feedstock	% Organic N		Nitrate-N (ppm)		Ammonium N (ppm)	
	Mean	Range	Mean	Range	Mean	Range
Dairy Manure	1.4	0.5 – 3.3	226.0	0.0 – 911.0	11.8	0.0 – 30.2
Food Scraps	-	-	241.0	0.0 – 1910.4	9.8	0.0 – 159.0

Horse Manure	1.6	1.2 – 1.9	151.3	50.0 – 294.0	-	-
Mixed Manure	2.3	0.0 – 7.1	133.4	0.0 – 682.0	4283.4	3.6 – 222464.0
Road-killed Mortality	0.9	-	-	-	-	-
Paper Residuals	1.7	0.8 – 2.7	355.2	1.7 – 1560.4	3006.5	3.0 – 17976.1
Poultry Manure	3.2	0.9 – 8.3	400.5	0.0 – 2520.0	2535.6	5.0 – 12020.8
Separated Dairy Manure	2.3	1.1 – 3.4	355.1	0.0 – 1069.0	5.8	4.4 – 17.1
Silage	2.2	1.5 – 2.5	229.7	2.5 – 821.8	2535.6	5.0 – 12020.8
Yard Waste	3.2	1.9 – 4.3	98.0	0.0 – 348.9	67.5	0.0 – 1196.6

Table 4 shows the pH, salinity (also called conductivity) and bulk density of the composts analyzed. pH is a measure of active acidity in the feedstock of compost. The pH scale is 0 (acidic) to 14 (basic) with 7 being neutral. Most finished composts will have pH values in the range of 5.0 to 8.5. Ideal pH depends on compost use. A lower pH is preferred for certain ornamental plants while a neutral pH is suitable for most applications. Other than the compost made from silage, the mean pH of these NY composts are in the finished compost range. However, many individual samples ran higher than 8.5 indicating they were probably not finished composting.

Salinity (conductivity) is a measure of the amount of soluble salts in the compost. Finished compost should be in the range of 1 – 4 mmhos/cm. Soluble salts include all soluble ions including available nutrients (beneficial to plants) and sodium and chloride (harmful to plants in excess). Excess salts (> 4) can be toxic to plants, while low salts (< 1) indicate low nutrient status. As the soluble salt level increases in the soil, it becomes more difficult for plants to extract water from soil. Composts with a salinity measurement of greater than 4 should not be used as planting media or in application with tender plants. They can be used for topdressing established plants or blended in as a soil amendment. Those with very high salts, such as the poultry manure compost, should be blended at a larger ratio of soil to compost, especially for salt sensitive plantings.

Bulk density is directly related to moisture content, and as with moisture, it can affect transportation. Finished compost should have a bulk density of around 30 lbs/ft^3. Many of the composts shown below have a mean bulk density higher than this, but they also all had mean moisture content higher than optimum as well. It may be necessary to allow the compost to dry some before use.

Table 4: Mean and range for pH, salinity and bulk density by major feedstock

Major Feedstock	pH		Salinity (mmhos/cm)		Bulk Density (lbs/ft^3)	
	Mean	Range	Mean	Range	Mean	Range
Dairy Manure	7.7	6.2 – 8.9	4.0	0.2 – 17.1	50.8	35.9 – 76.8
Food Scraps	7.8	6.6 – 8.7	2.5	0.0 – 5.5	47.4	46.6 – 48.5
Horse Manure	8.1	7.8 – 8.3	5.5	5.2 – 5.8	37.3	34.0 – 39.0
Mixed Manure	8.6	7.5 – 11.8	0.6	0.0 – 3.8	50.8	35.9 – 76.8
Road-killed Mortality	7.3	6.6 – 8.1	0.6	0.2 – 2.0	32.7	24.0 – 37.0
Paper Residuals	8.7	7.6 – 12.2	0.2	0.0 – 0.6	59.2	51.2 – 69.9
Poultry Manure	8.1	6.4 – 9.3	12.3	1.1 – 26.0	42.4	28.3 – 62.0
Separated Dairy Manure	8.0	6.9 – 8.7	4.1	0.8 – 11.4	43.3	24.0 – 63.0
Silage	9.3	8.3 – 12.2	0.1	0.0 – 0.3	53.5	43.7 – 64.3
Yard Waste	7.9	6.3 – 8.6	2.7	0.4 – 9.8	45.1	14.5 – 99.9

Mean and range of plant macronutrients in the composts tested are shown in Table 5. In addition to nitrogen, potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P), and sulfur (S) are macronutrients needed by plants. There are minimum concentrations of macronutrients required for plant growth; they also can be toxic if there is too much. The amount depends on the plant and the soil. In addition, the amount in compost may or may not be plant available.

Potassium is associated with movement of water, nutrients, and carbohydrates in plant tissue. If K is deficient in the soil, growth is stunted and yield is reduced. Depending on the plant being grown, sufficient K concentration in the soil can range from 0.2-10%. As K in compost is not bound in the organic matter, it is immediately available to plants. If your soil is deficient in K, the manure composts would be a good choice to remediate that.

Unlike K, P is bound in the organic matter of the compost and, like N, will continue to degrade slowly when applied to soil, becoming gradually available to plants. A normal range for P in finished composts would be between 0.5 and 3.4%. Almost all of the composts analyzed fall within that range. Excess P can be an environmental contaminant through runoff. Optimum concentration of Ca, Mg and S will depend on plant and soil. Paper residual, silage and poultry manure composts sampled have significantly higher Ca concentration than the others, while manure composts have higher Mg and S concentrations.

Table 5: Mean and range for K, P, Ca, Mg and S by major feedstock

Major Feedstock	% K		% P		% Ca		% Mg		% S	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Dairy Manure	0.8	0.1 – 3.9	0.5	0.1 – 1.5	2.6	1.0 – 12.0	0.7	0.0-2.0	0.4	0.3 – 0.5
Food Scraps	0.7	0.2 – 1.3	0.3	0.1 – 1.4	4.8	1.0 – 50.7	0.6	0.2 – 1.6	0.2	0.2 – 0.3
Horse Manure	1.9	1.4 – 2.6	0.4	0.4 – 0.4	2.3	2.1 – 2.6	0.9	0.9 – 1.0	-	-
Mixed Manure	1.2	0.2 – 5.0	0.9	0.1 – 2.4	5.8	0.7 – 17.6	0.6	0.2 – 1.7	0.4	0.4 – 0.4
Road-killed Mortality	0.2	0.2 – 0.4	0.2	0.1 – 0.4	-	-	-	-	-	-
Paper Residuals	2.9	0.3– 20.1	0.5	0.4 – 0.7	11.1	0.3 – 18.8	0.5	0.3 – 1.4	-	-
Poultry Manure	2.1	0.2 – 3.2	2.5	0.2 – 5.9	10.8	5.0 – 17.0	0.9	0.0 – 1.0	-	-
Separated Dairy Manure	1.1	0.3 – 2.2	0.5	0.1 – 1.7	3.5	2.0 – 7.0	0.9	0.6 – 1.0	-	-
Silage	0.8	0.6 – 1.1	0.7	0.5 – 0.8	10.6	0.7 – 15.8	0.5	0.4 – 0.6	-	-
Yard Waste	0.5	0.1 – 1.4	0.2	0.0 – 0.8	2.6	0.5 – 9.7	0.6	0.1 – 4.0	0.2	0.2 – 0.3

Iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo) and nickel (Ni) are micronutrients need by plants. The minimum concentrations for plant growth are generally in the range of 0.1 to 100 ppm. They can also be toxic if there is too much. The amount depends on the plant and the soil. The amount in compost may or may not be available. Tables 6 and 7 show the mean and range for these micronutrients in the composts tested. Micronutrients in these composts meet the minimum requirements for plant growth. Maximum concentration of those that are considered pollutants by NYS (Zn, Cu, Mo and Ni) will be discussed below with other metals (pollutants). Availability of the other micronutrients is dependent on soil pH, soil type and plant type. To know whether or not the concentrations of these micronutrients are deficient or excessive in the compost, one would have to know the requirements of the plants.

Table 6: Mean and range for Fe, Mn, Zn and Cu by major feedstock

Major Feedstock	Fe (ppm)		Mn (ppm)		Zn (ppm)		Cu (ppm)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Dairy Manure	9804	99 – 19007	441	35 – 936	141	89 – 444	52	14 – 194
Food Scraps	13590	1 – 279000	604	570 – 627	194	53 – 690	60	26 – 125
Horse Manure	9125	6370 – 11304	-	-	118	112 – 128	29	27 – 33
Mixed Manure	9769	2273 – 27050	1417	141 – 6170	113	46 – 250	58	26 – 89
Road-killed Mortality	-	-	-	-	-	-	-	-
Paper Residuals	10262	3924 – 42583	1501	253 – 5643	136	68 – 486	75	48 – 112
Poultry Manure	3601	45 – 11049	-	-	431	144 – 673	48	13 – 184
Separated Dairy Manure	3295	300 – 13676	348	88 – 690	327	111 – 1660	386	30 - 1076
Silage	4952	1032 - 9625	392	137 – 979	93	21 – 157	57	28 – 100
Yard Waste	7801	3010 - 16385	336	123 – 579	126	40 – 1100	54	11 – 517

Table 7: Mean and range for B, Mo and Ni by major feedstock

Major Feedstock	B (ppm)		Mo (ppm)		Ni (ppm)	
	Mean	Range	Mean	Range	Mean	Range
Food Scraps	29.2	10.0 – 160.0	1.3	0.6 – 15.7	-	-
Yard Waste	18.4	6.8 – 40.3	0.9	0.0 – 8.5	5.8	0.6 – 11.1

The New York State Department of Environmental Conservation (NYSDEC) regulates the land application of compost made from biosolids (sewage). NYSDEC Part 360-5 are the regulations for composting facilities. Biosolids facilities are required to analyze compost annually. Part of that testing is for metals. The limits for these pollutants in biosolids compost are shown in Table 8. Both Cu and Zn were highest in the separated dairy manure compost (Table 6), but were 4 and 7 time lower, respectively, than the monthly average concentration limits set for biosolids compost. Molybdenum and Ni, although only analyzed for food scraps and yard waste compost were both well below the limits as well. Table 9 shows the mean and range of cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg) and selenium (Se) in the composts tested. Cadmium ranged from 0 ppm to 6 ppm in all composts, 40% less than the limit. Chromium, and selenium (only tested for in yard waste compost) were 10 and 100 times lower than the limit. Mercury in food scrap and yard waste compost were also 10 and 20 times lower, respectively than the limit. Mean Pb concentration in dairy manure, food scrap and yard waste compost was 30, 3 and 6 times lower, respectively, than the limit. The range of Pb concentration in both dairy manure and food scrap compost remained below the limit. Although the maximum value in the range of Pb for yard waste compost is 566 ppm, then next highest concentration was 181 ppm, so only 1 sample exceeded the pollutant limit.

Table 8: DEC Part 360-5.10: Table 7 Pollutant Limits – Products

Parameter	Monthly Average Concentration (ppm, dry weight)	Maximum Concentration (ppm, dry weight)
Arsenic (As)	41	75
Cadmium (Cd)*	10	85
Chromium (Cr)	1000	1000
Copper (Cu)	1500	4300
Lead (Pb)	300	840
Mercury (Hg)	10	57
Molybdenum (Mo)	40	75
Nickel (Ni)	200	420
Selenium (Se)	100	100
Zinc (Zn)	2500	7500

* If the monthly average cadmium concentration exceeds 5 ppm, dry weight basis, the cadmium/zinc ratio must not exceed 0.015.

Table 9: Mean and range for Cd, Cr, Pb, Hg and Se by major feedstock

Major Feedstock	Cd (ppm)		Cr (ppm)		Pb (ppm)		Hg (ppm)		Se (ppm)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Dairy Manure	2.2	1.0 – 6.0	-	-	10.8	0.0 – 21.9	-	-	-	-
Food Scraps	-	-	-	-	94.4	11.3 – 267.0	0.13	0.03 – 0.23	-	-
Horse Manure	2.0	2.0 – 2.1	-	-	-	-	-	-	-	-
Poultry Manure	3.9	1.0 – 6.0	-	-	-	-	-	-	-	-
Separated Dairy Manure	2.1	0.0 – 4.0	-	-	-	-	-	-	-	-
Yard Waste	0.4	0.0 – 1.1	7.8	3.6 – 20.8	60.3	6.5 – 566.0	0.07	0.01 – 0.31	1.0	0.3 – 0.6

Additional parameters of interest include water holding capacity (WHC), pathogens (fecal coliforms and/or salmonella) and % germination and germinable weeds (Tables 10 and 11). Water holding capacity is a test that measures how well water is held in the pores between the compost particles and in the thin films surrounding particles. Since humus particles absorb water, composts with higher organic matter should have higher WHC and thus help soils, especially sandy soils, better hold water. All of the composts tested had similar WHC.

Presence of pathogens is a test of the safety to humans in handling the compost. In addition, it is required by NYSDEC for biosolids compost to pass either the fecal coliforms limit (< 1000 MPN/g dry weight) or salmonella limit (< 3 MPN/4 g dry weight) in order to be considered a Class A compost. The dairy manure composts had significantly higher numbers of fecal coliforms than the other composts, but the median values (where most samples fell) for both of these were 36 and 11.5, indicating that the mean was brought up by a few outliers).

Germination percent is tested to see if the compost contains toxic contaminants that inhibit seed germination without actually identifying what the specific contaminant is. Germination was good in all composts except the poultry manure compost that we had previously indicated was not good for starting seedlings due to its high salt content. Weed seeds were killed in the composts based on the number of germinable weeds/liter.

Table 10: Mean and range for WHC, fecal coliforms and salmonella by major feedstock

Major Feedstock	WHC		Fecal coliforms (MPN/g)		Salmonella (MPN/4g)	
	Mean	Range	Mean	Range	Mean	Range
Dairy Manure	153.6	68.0 – 431.2	8286.8	1.0 – 500000	1.9	0.7 – 5.3
Food Scraps	-	-	13.7	0.0 – 33.0	-	-
Horse Manure	185.3	174.0 – 206.0	2.9	2.0 – 3.9	-	-
Poultry Manure	125.1	82.0 – 177.0	1144.5	0.2 – 53000	0.7	0.3 – 1.6
Separated Dairy Manure	193.6	87.4 – 577.6	2018.5	1.0 – 50001	0.9	0.1 – 2.0
Yard Waste	-	-	438.8	0.0 – 1600.0		

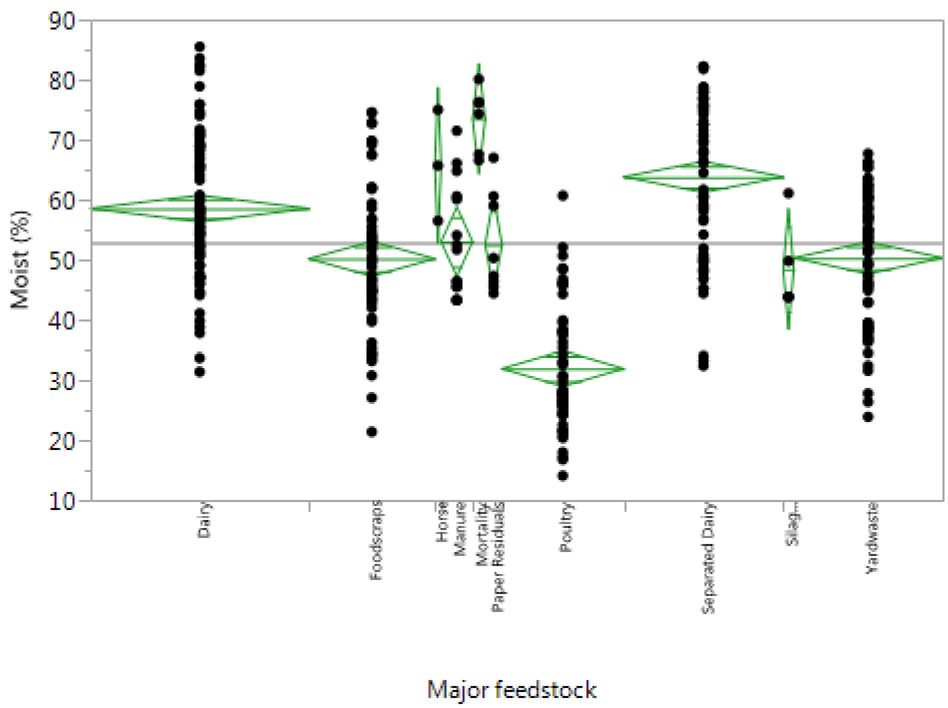
Table 11: Mean and range for germination and germinable weeds by major feedstock

Major Feedstock	% germination		Germinable weed (#/liter)	
	Mean	Range	Mean	Range
Dairy Manure	97.5	73.0 – 102.0	6.5	0.0 – 99.0
Horse Manure	100.0	98.0 – 111.0	0.0	0.0 – 0.0
Poultry Manure	61.8	5.0 – 108.0	23.0	0.0 – 105.0
Separated Dairy Manure	96.4	57.0 – 102.0	11.9	0.0 – 227.0

Appendix A: Database of 488 Composts from 62 NY facilities: 124 Dairy, 98 Poultry, 96 Separated dairy, 73 yard waste, 60 food scraps, 15 Mixed manure, 8 paper residuals, 6 Mortality, 5 silage, 3 horse manure

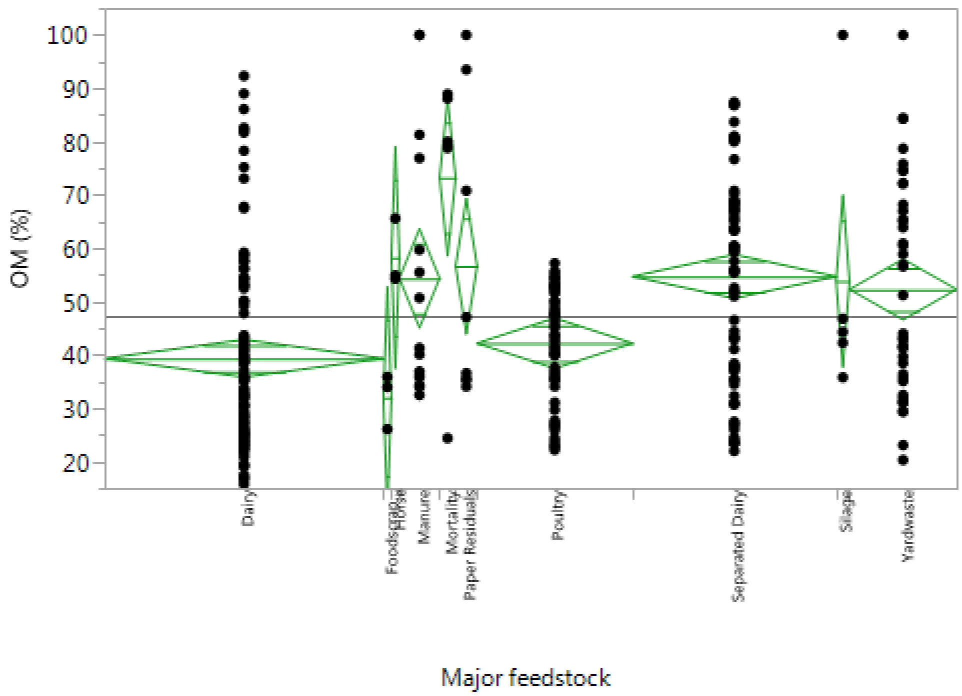
% Moisture (n=406): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Mortality	6	73.5^{A}	5.3	66.6	80.1	75.2
Horse	3	65.7^{ABCD}	9.3	56.5	75.0	65.7
Separated Dairy	76	63.8^{AC}	13.1	32.4	82.2	67.1
Dairy	104	58.5^{ABC}	11.3	31.4	85.5	57.0
Manure	15	53.0^{BD}	9.4	43.3	71.5	51.7
Paper Residuals	8	52.6^{BCD}	8.5	44.4	67.0	48.8
Yard waste	71	50.3^{D}	11.0	23.9	67.7	53.0
Food scraps	60	50.2^{D}	12.3	21.4	74.6	49.7
Silage	5	48.5^{BCDE}	7.6	43.8	61.1	43.8
Poultry	58	31.9^{E}	10. 2	14.1	60.7	28.1



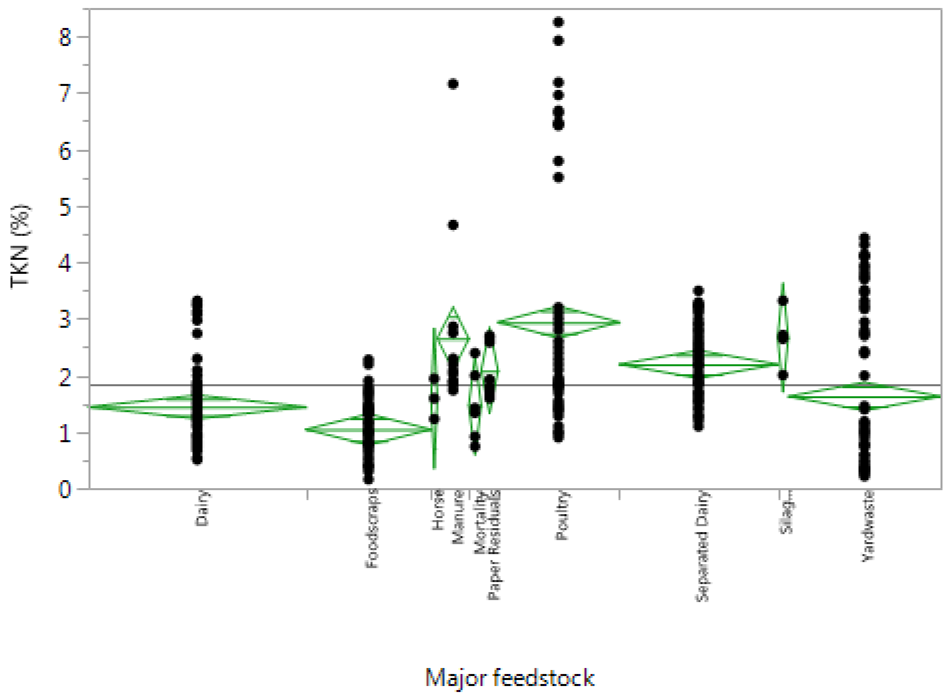
% Organic Matter (dm basis) (n=318): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Mortality	6	73.3^{A}	24.4	24.4	88.9	79.7
Horse	3	58.3^{ABCD}	6.4	54.3	65.6	54.9
Paper Residuals	8	56.6^{AB}	27.6	34.1	100.0	41.9
Separated Dairy	76	54.7^{B}	19.4	22.0	87.4	58.9
Manure	15	54.4^{BC}	24.0	32.5	100.0	41.3
Silage	5	53.8^{ABCD}	26.1	35.8	100.0	44.3
Yard waste	40	52.3^{BC}	19.8	20.3	100.0	47.6
Poultry	58	42.2^{D}	10.4	22.2	57.2	43.7
Dairy	104	39.4^{D}	18. 1	15.8	92.3	34.5
Food scraps	3	32.0^{CD}	5.2	26.1	35.9	34.0



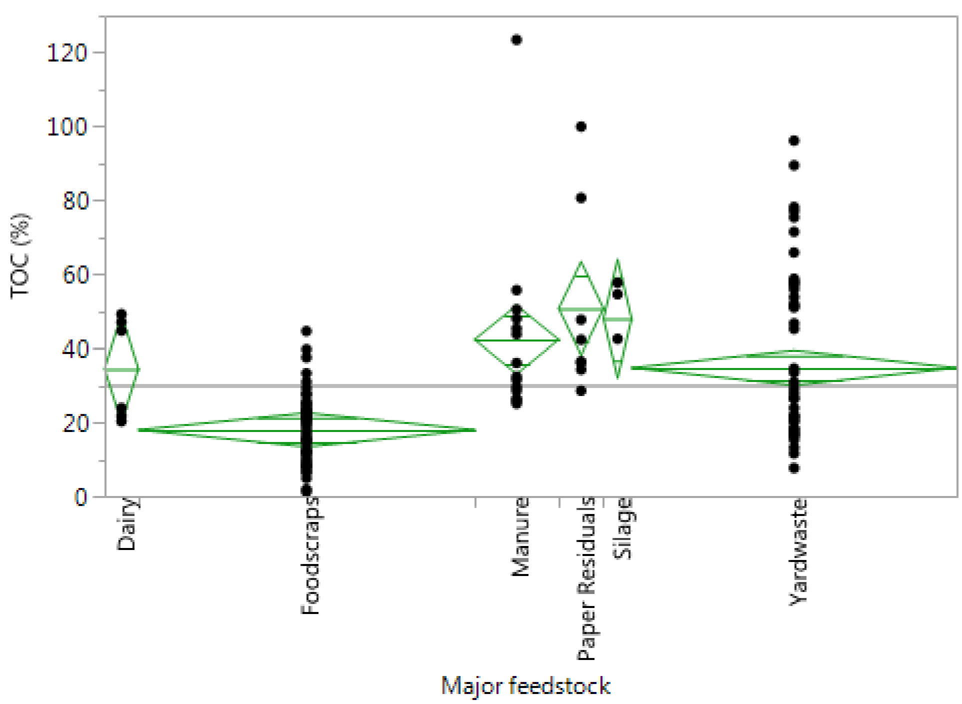
% TKN (n=408): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Poultry	58	2.9^{A}	2.0	0.9	8.3	2.2
Silage	5	2.7^{ABC}	0.5	2.0	3.3	2.7
Manure	15	2.7^{AB}	1.4	1.7	7.2	2.2
Separated Dairy	76	2.2^{BC}	0.7	1.1	3.4	2.2
Paper Residuals	8	2.1^{BCD}	0.5	1.6	2.7	1.9
Yard waste	73	1.6^{D}	1.4	0.2	4.4	1.1
Horse	3	1.6^{BCDE}	0.4	1.2	1.9	1.6
Mortality	6	1.5^{CDE}	0.6	0.7	2.4	1.4
Dairy	104	1.4^{D}	0.6	0.5	3.3	1.4
Food scraps	60	1.0^{E}	0.5	0.2	2.3	1.0



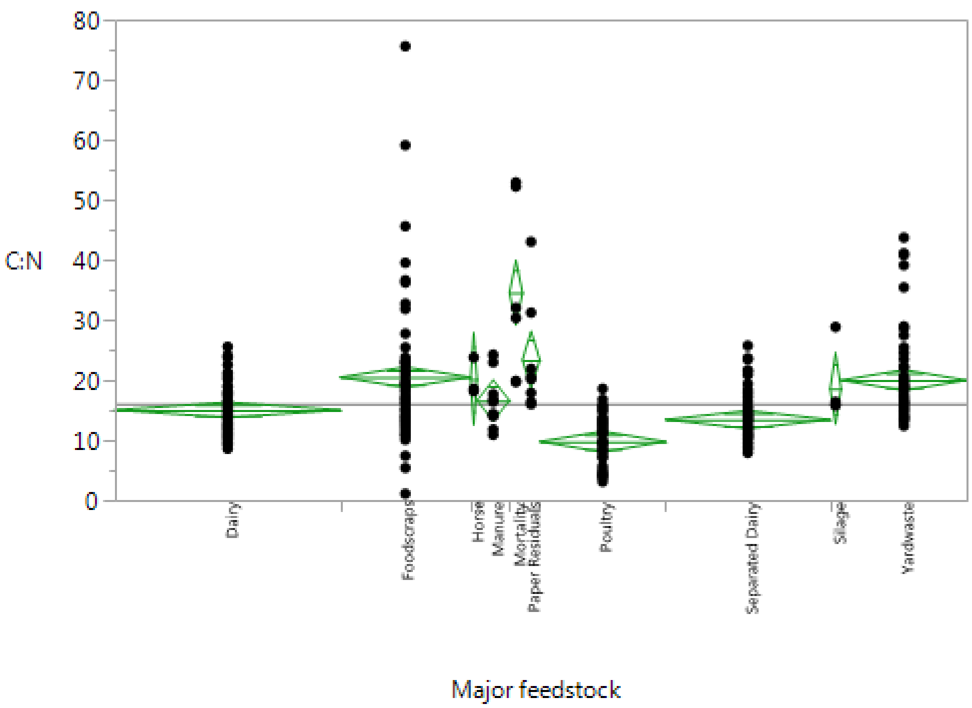
% TOC (n=155): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Paper Residuals	8	50.8^{A}	25.6	28.6	100.0	39.4
Silage	5	48.0^{AB}	7.5	42.5	57.7	42.7
Manure	15	42.3^{AB}	24.5	25.1	123.5	32.4
Yard waste	58	34.8^{B}	22.3	7.7	96.2	24.0
Dairy	6	34.5^{ABC}	13.8	20.3	49.2	34.3
Food scraps	60	18.0^{C}	9.3	1.2	44.6	18.0



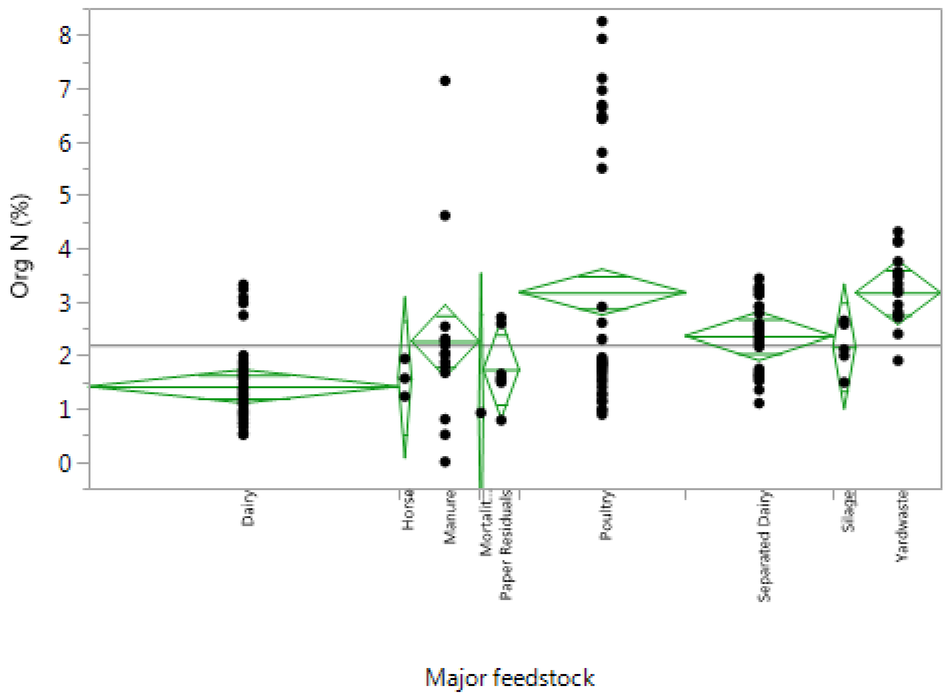
C:N ratio (n=383): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Mortality	6	34.5^{A}	14.9	19.7	52.9	31.2
Paper Residuals	8	23.4^{B}	9.3	16.0	43.0	20.4
Food scraps	60	20.5^{B}	12.2	1.1	75.6	18.3
Horse	3	20.2^{BCD}	3.1	18.2	23.8	18.6
Yard waste	58	20.0^{BC}	7.3	12.4	43.7	18.7
Silage	5	18.6^{BCD}	5.7	15.8	28.8	16.0
Manure	15	16.6^{CD}	3.6	10.9	24.2	16.5
Dairy	104	15.1^{D}	3.8	8.6	25.5	14.7
Separated Dairy	76	13.4^{D}	3.5	7.9	25.7	13.1
Poultry	58	9.8^{E}	3.7	3.1	18.6	9.9



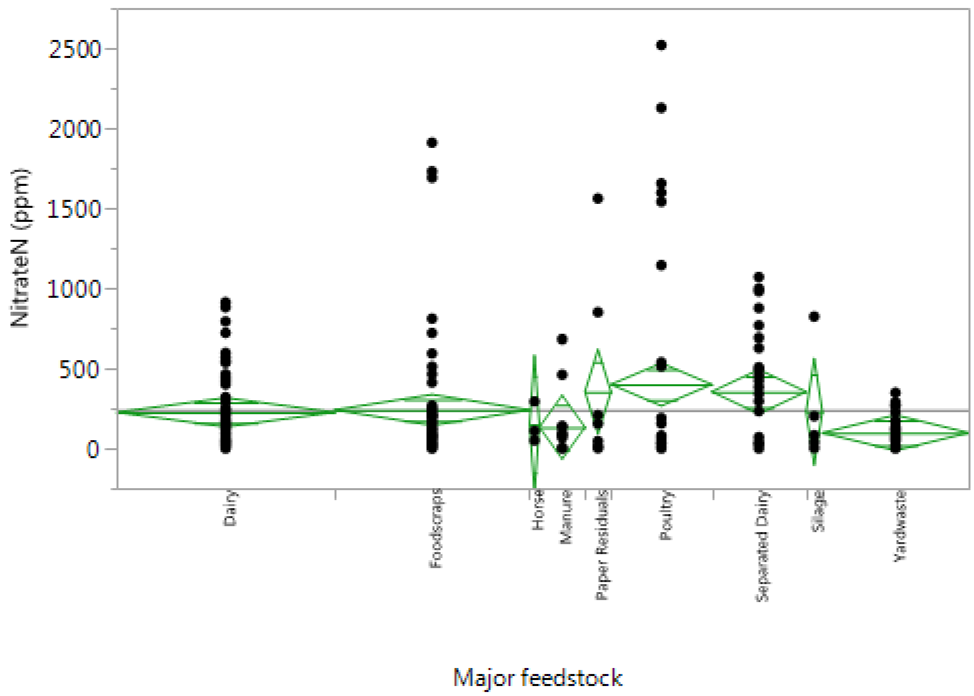
% Organic N (n=332): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Poultry	37	3.2^{A}	2.4	0.9	8.3	1.9
Yard waste	19	3.2^{AB}	0.8	1.9	4.3	3.2
Separated Dairy	33	2.4^{C}	0.6	1.1	3.4	2.4
Manure	15	2.3^{C}	1.7	0.0	7.1	2.0
Silage	5	2.2^{ABCD}	0.5	1.5	2.6	2.1
Paper Residuals	8	1.7^{CD}	0.6	0.8	2.7	1.6
Horse	3	1.6^{BCD}	0.4	1.2	1.9	1.6
Dairy	69	1.4^{D}	0.7	0.5	3.3	1.3
Mortality	1	0.9^{ABCD}		0.9	0.9	0.9



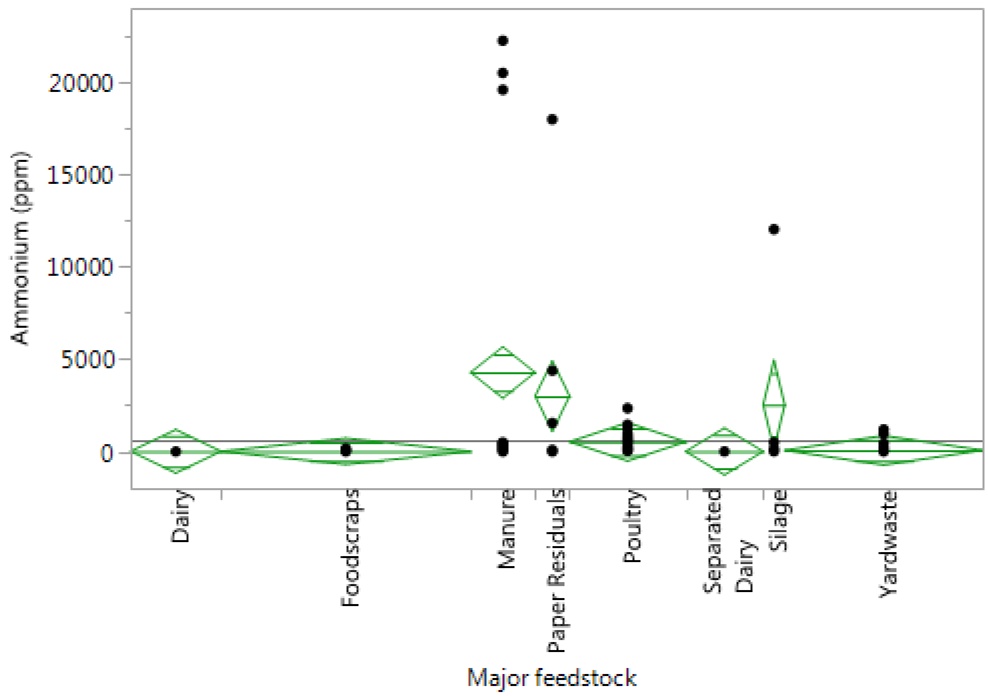
Nitrate-N (ppm) (n=262): Means with different superscripts are significantly different. p=0.0025

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Poultry	31	400.5^{A}	719.4	0.0	2520.0	32.0
Paper Residuals	8	355.2^{ABC}	562.7	1.7	1560.4	100.4
Separated Dairy	29	355.1^{AB}	376.4	0.0	1069.0	296.0
Food scraps	60	241.0^{ABC}	394.6	0.0	1910.0	130.0
Silage	5	229.7^{ABC}	339.4	2.5	821.8	83.2
Dairy	67	226.0^{BC}	239.4	0.0	911.0	167.0
Horse	3	151.3^{ABC}	127.1	50.0	294.0	110.0
Manure	14	133.4^{BC}	197.3	0.0	682.0	87.0
Yard waste	45	98.0^{C}	91.1	0.0	348.9	63.5



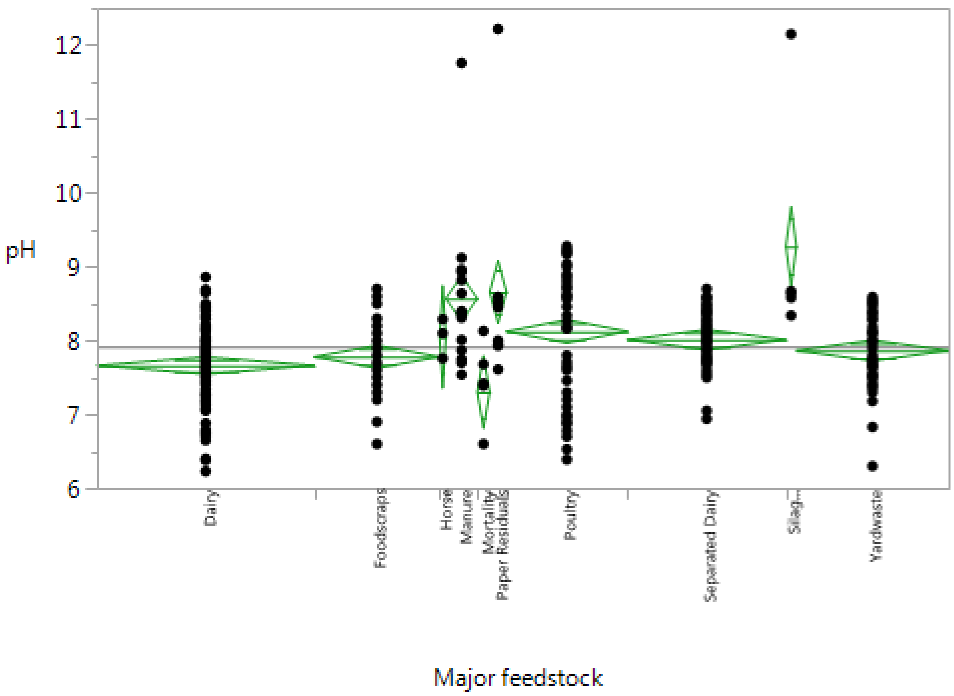
Ammonium N (ppm) (n=198): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Manure	15	4283.4^{A}	8552.3	3.6	222464.0	173.9
Paper Residuals	8	3006.5^{AB}	6239.0	3.0	17976.1	53.0
Silage	5	2535.6^{AB}	5306.2	5.0	12020.8	140.2
Poultry	27	529.8^{B}	552.0	41.3	2347.2	424.4
Yard waste	46	67.5^{B}	231.3	0.0	1196.6	0.5
Dairy	21	11.8^{B}	8.8	0.0	30.2	9.0
Food scraps	58	9.8^{B}	26.3	0.0	159.0	2.8
Separated Dairy	18	5.8^{B}	3.3	4.4	17.1	4.5



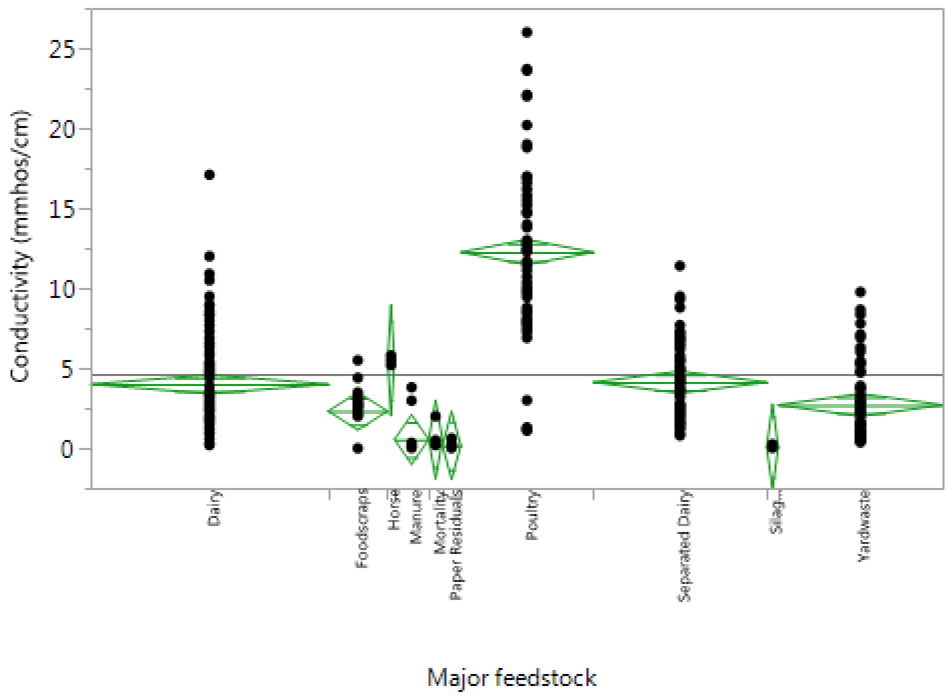
pH (n=408): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Silage	5	9.3^{A}	1.6	8.3	12.2	8.6
Paper Residuals	8	8.7^{ABC}	1.5	7.6	12.2	8.2
Manure	15	8.6^{AB}	1.0	7.5	11.8	8.4
Poultry	58	8.1^{BCD}	0.9	6.4	9.3	8.4
Horse	3	8.1^{ABCDE}	0.3	7.8	8.3	8.1
Separated Dairy	76	8.0^{CD}	0.3	6.9	8.7	8.0
Yard waste	73	7.9^{DE}	0.4	6.3	8.6	8.0
Food scraps	60	7.8^{DE}	0.4	6.6	8.7	7.7
Dairy	104	7.7^{E}	0.5	6.2	8.9	7.7
Mortality	6	7.3^{DE}	0.6	6.6	8.1	7.4



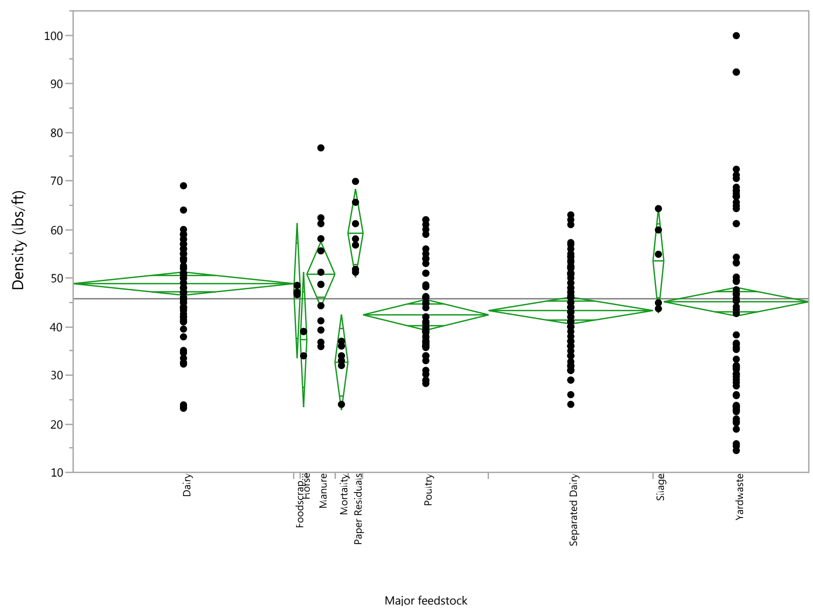
Salinity (mmhos/cm) (n=373): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Poultry	58	12.3^{A}	5.5	1.1	26.0	11.6
Horse	3	5.5^{BC}	0.3	5.2	5.8	5.5
Separated Dairy	76	4.1^{B}	2.2	0.8	11.4	4.1
Dairy	104	4.0^{B}	2.8	0.2	17.1	3.0
Yard waste	72	2.7^{BC}	2.2	0.4	9.8	2.1
Food scraps	26	2.3^{BC}	1.4	0.0	5.5	2.6
Manure	15	0.6^{C}	1.2	0.0	3.8	0.1
Mortality	6	0.6^{BC}	0.7	0.2	2.0	0.2
Paper Residuals	8	0.2^{C}	0.2	0.0	0.6	0.1
Silage	5	0.1^{BC}	0.1	0.0	0.3	0.1



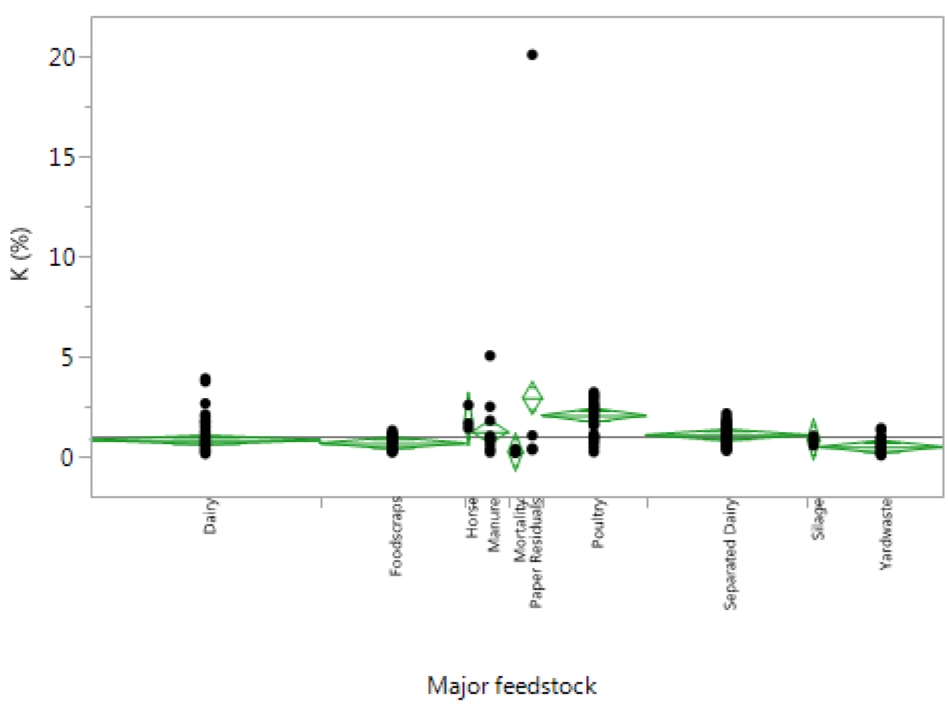
Bulk Density (lbs/ft) (n=340): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Paper Residuals	7	59.2^{A}	6.9	51.2	69.9	58.1
Silage	5	53.5^{ABC}	9.1	43.7	64.3	54.9
Manure	13	50.8^{AB}	11.9	35.9	76.8	48.7
Dairy	102	48.9^{B}	8.2	23.2	69.0	50.0
Food scraps	3	47.4^{ABCD}	1.0	46.6	48.5	47.1
Yard waste	67	45.1^{BC}	21.2	14.5	99.9	43.5
Separated Dairy	76	43.3^{C}	8.9	24.0	63.0	43.5
Poultry	58	42.4^{CD}	8.9	28.3	62.0	39.4
Horse	3	37.3^{BCD}	2.9	34.0	39.0	39.0
Mortality	6	32.7^{D}	4.6	24.0	37.0	33.5



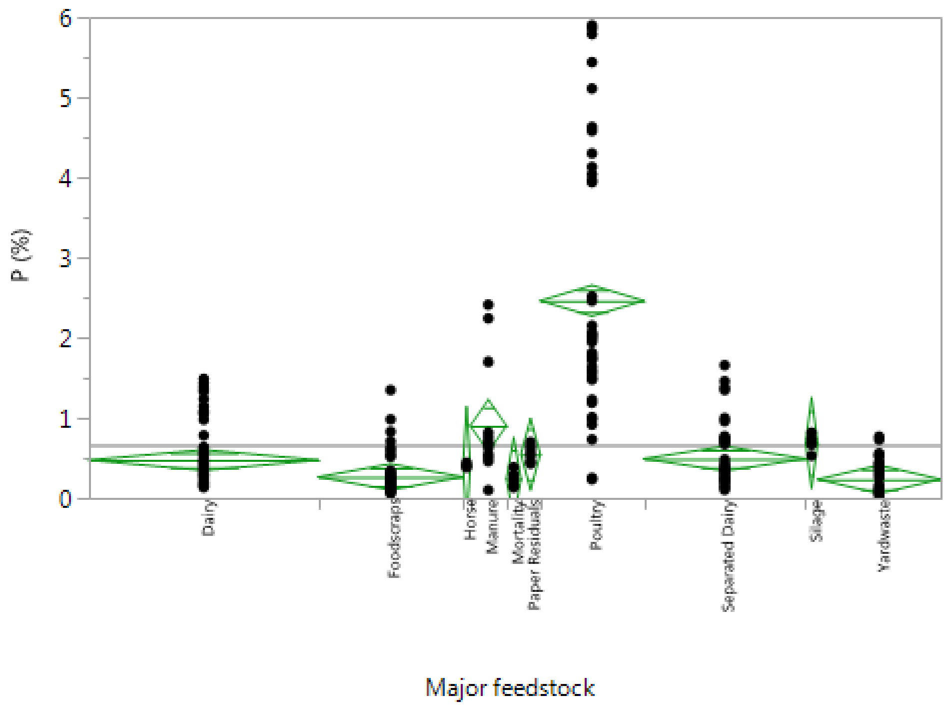
% K (n=353): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Paper Residuals	8	2.9^{A}	6.9	0.3	20.1	0.4
Poultry	43	2.1^{AB}	0.9	0.2	3.2	2.3
Horse	3	1.9^{ABC}	0.6	1.4	2.6	1.7
Manure	15	1.2^{BC}	1.2	0.2	5.0	0.9
Separated Dairy	67	1.1^{C}	0.5	0.3	2.2	1.1
Silage	5	0.8^{ABC}	0.2	0.6	1.1	0.9
Dairy	95	0.8^{C}	0.7	0.1	3.9	0.6
Food scraps	60	0.7^{C}	0.3	0.2	1.3	0.7
Yard waste	51	0.5^{C}	0.3	0.1	1.4	0.5
Mortality	6	0.2^{C}	0.1	0.2	0.4	0.2



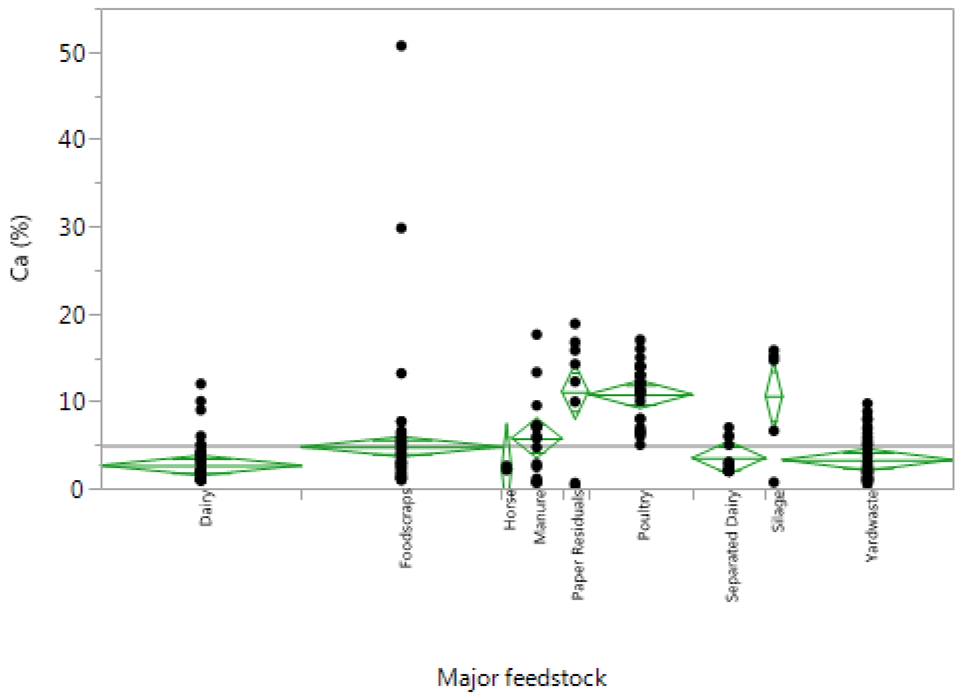
% P (n=353): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Poultry	43	2.5^{A}	1.6	0.2	5.9	1.9
Manure	15	0.9^{B}	0.7	0.1	2.4	0.7
Silage	5	0.7^{BC}	0.1	0.5	0.8	0.7
Paper Residuals	8	0.5^{BC}	0.1	0.4	0.7	0.6
Separated Dairy	67	0.5^{BC}	0.4	0.1	1.7	0.4
Dairy	95	0.5^{BC}	0.3	0.1	1.5	0.4
Horse	3	0.4^{BC}	0.0	0.4	0.4	0.4
Food scraps	60	0.3^{C}	0.2	0.1	1.4	0.2
Yard waste	51	0.2^{BC}	0.2	0.0	0.8	0.1
Mortality	6	0.2^{C}	0.1	0.1	0.4	0.2



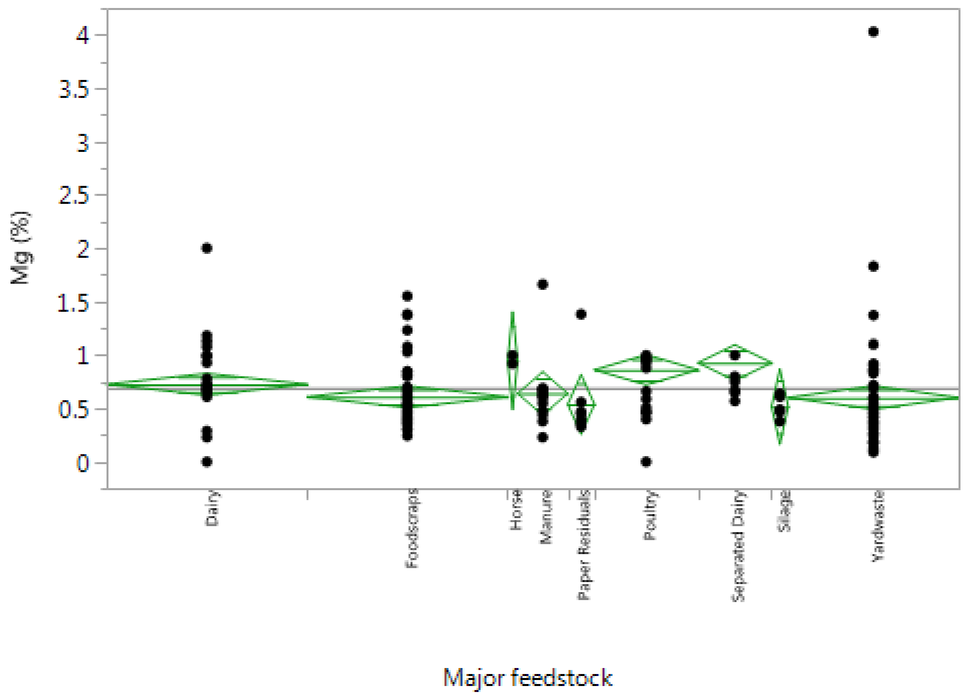
% Ca (n=255): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Paper Residuals	8	11.1^{AB}	7.1	0.3	18.8	13.3
Poultry	31	10.8^{A}	3.3	5.0	17.0	11.4
Silage	5	10.6^{ABC}	6.7	0.7	15.8	14.7
Manure	15	5.8^{BCD}	4.9	0.7	17.6	5.8
Food scraps	60	4.8^{CD}	7.3	1.0	50.7	3.0
Separated Dairy	22	3.5^{D}	1.8	2.0	7.0	2.8
Yard waste	51	3.3^{D}	2.6	0.5	9.7	2.2
Dairy	60	2.6^{D}	2.3	1.0	12.0	2.0
Horse	3	2.3^{ABCD}	0.5	2.1	2.6	2.2



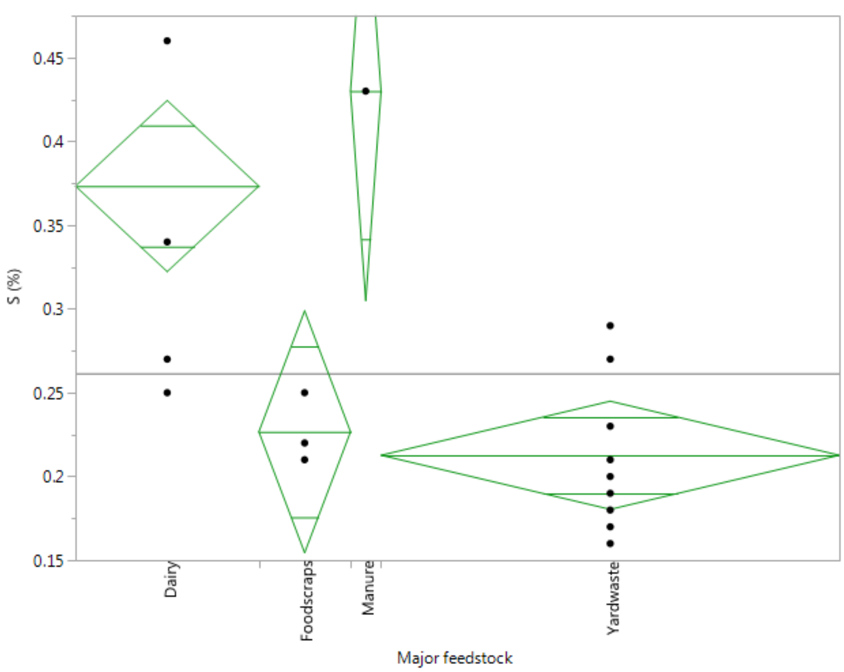
% Mg (n=255): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Horse	3	0.9^{AB}	0.0	0.9	1.0	0.9
Separated Dairy	22	0.9^{A}	0.1	0.6	1.0	1.0
Poultry	31	0.9^{AB}	0.3	0.0	1.0	1.0
Dairy	60	0.7^{AB}	0.5	0.0	2.0	1.0
Manure	15	0.6^{AB}	0.3	0.2	1.7	0.6
Food scraps	42	0.6^{B}	0.3	0.2	1.6	0.5
Yard waste	48	0.6^{B}	0.6	0.1	4.0	0.5
Paper Residuals	8	0.5^{AB}	0.3	0.3	1.4	0.4
Silage	5	0.5^{AB}	0.1	0.4	0.6	0.5



% S (n=25): Means with different superscripts are significantly different. p<.0001

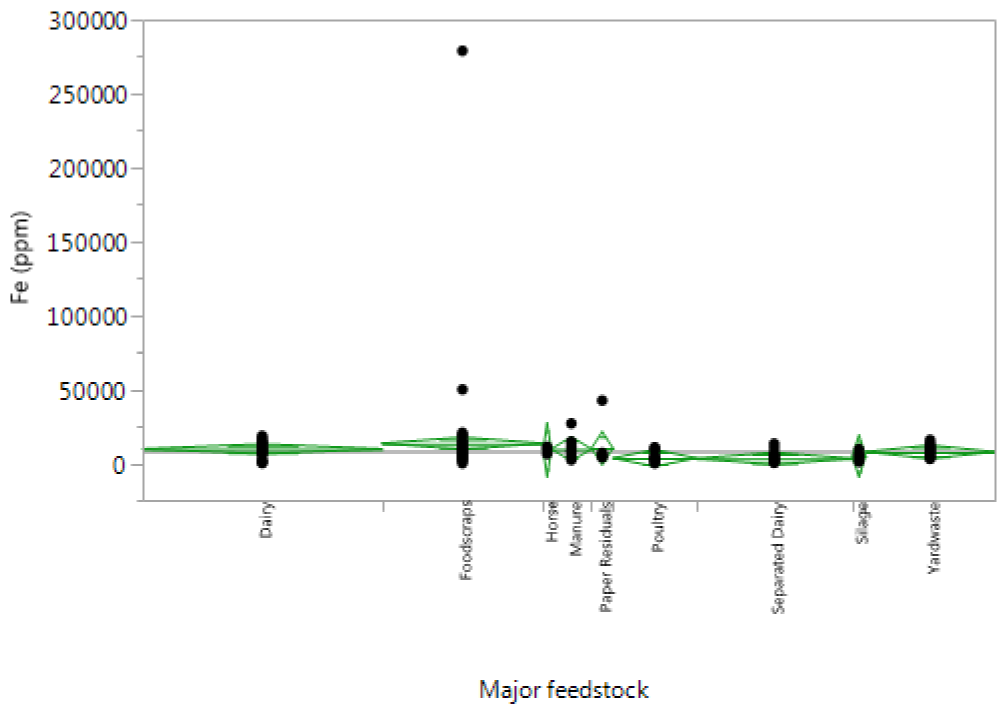
Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Manure	1	0.4^{A}		0.4	0.4	0.4
Dairy	6	0.4^{A}	0.1	0.3	0.5	0.4
Food scraps	3	0.2^{B}	0.0	0.2	0.3	0.2
Yard waste	15	0.2^{B}	0.0	0.2	0.3	0.2



Fe (ppm) (n=317): Means with different superscripts are significantly different. p<.0449

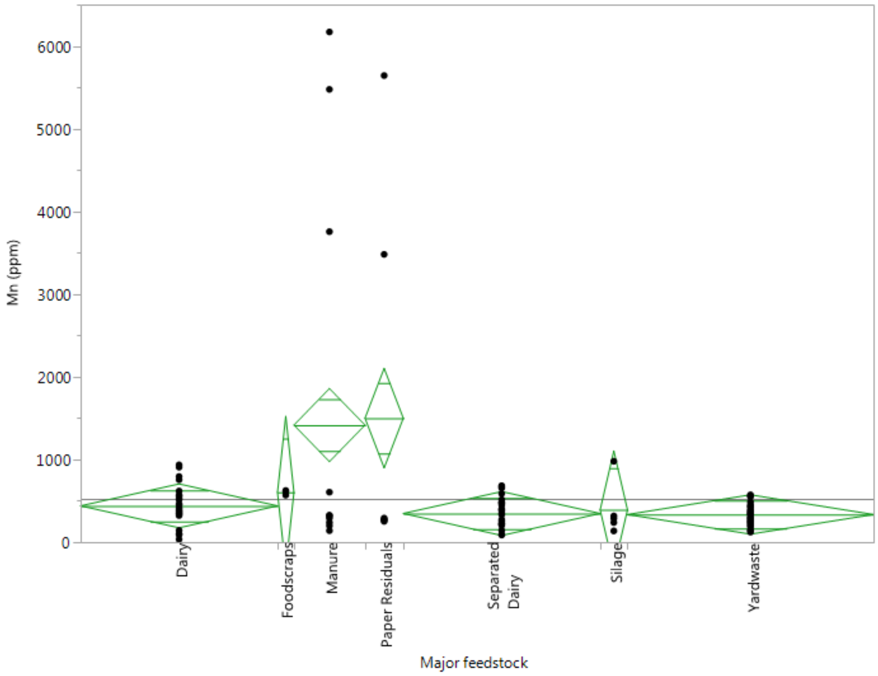
Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median

Food scraps	69	13589.8^{A}	35563.9	1.0	279000.0	7705.0
Paper Residuals	8	10262.0^{AB}	13096.4	3923.6	42582.7	5845.8
Dairy	89	9804.3^{AB}	4408.3	98.6	19007.0	10130.1
Manure	15	9768.6^{AB}	5812.8	2273.3	27049.5	8712.8
Horse	3	9124.9^{AB}	2516.9	6369.7	11303.5	9701.5
Yard waste	48	7801.3^{AB}	3506.0	3010.0	16385.0	7845.0
Silage	5	4952.2^{AB}	3315.1	1031.5	9625.1	5381.9
Poultry	31	3601.0^{AB}	3461.7	45.4	11049.3	2197.4
Separated Dairy	58	3294.7^{B}	2881.6	300.0	13676.2	2820.0



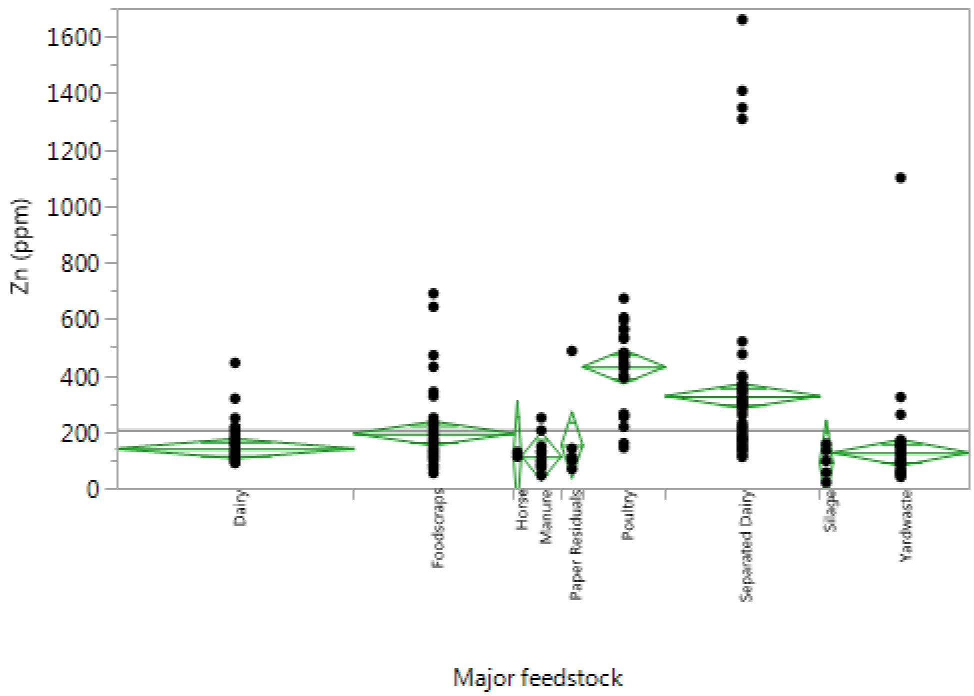
Mn (ppm) (n=145): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Paper Residuals	7	1500.9^{A}	2182.1	252.8	5642.7	292.7
Manure	13	1417.0^{A}	2181.4	140.6	6170.2	324.5
Food scraps	3	603.7^{AB}	29.9	570.0	627.0	614.0
Dairy	36	440.5^{B}	214.7	35.0	936.0	377.0
Silage	5	392.4^{B}	335.0	137.4	978.8	288.9
Separated Dairy	36	347.7^{B}	176.2	88.0	690.0	344.0
Yard waste	45	336.1^{B}	116.2	123.0	579.0	343.0



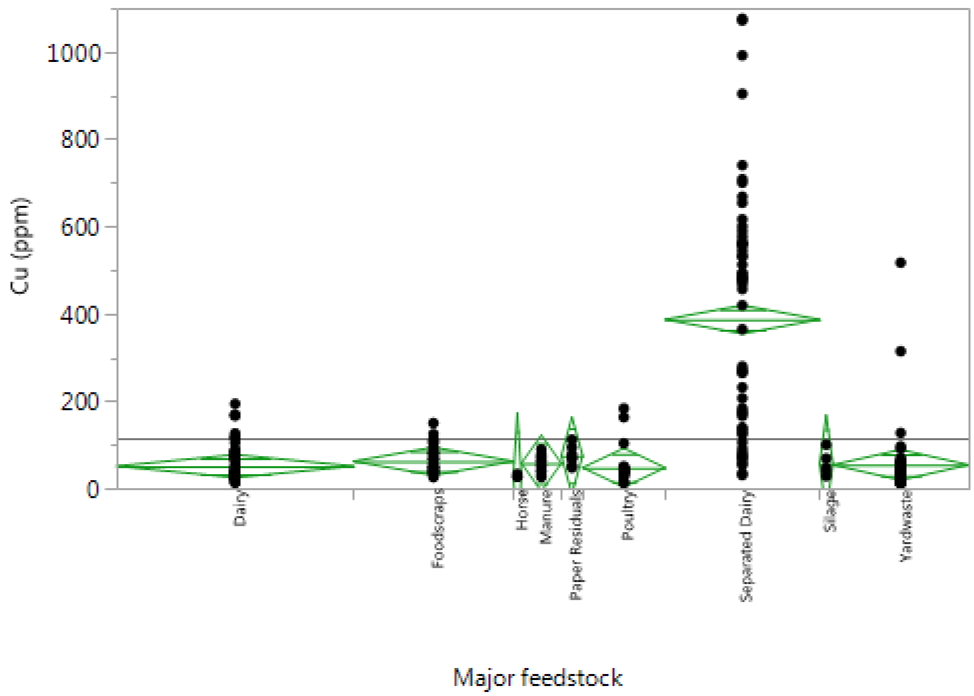
Zn (ppm) (n=320): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Poultry	31	430.7[A]	141.1	143.8	672.6	464.5
Separated Dairy	58	326.9[AB]	319.5	110.8	1660.0	225.8
Food scraps	60	194.3[C]	121.1	53.3	690.0	171.5
Paper Residuals	8	153.0[BC]	136.1	68.4	486.2	108.3
Dairy	89	140.6[C]	51.7	89.0	444.4	125.6
Yard waste	51	126.1[C]	149.6	40.2	1100.0	93.7
Horse	3	118.1[ABC]	8.8	112.3	128.2	113.7
Manure	15	113.1[C]	53.8	45.5	249.5	94.2
Silage	5	92.9[BC]	55.5	20.8	157.1	97.3



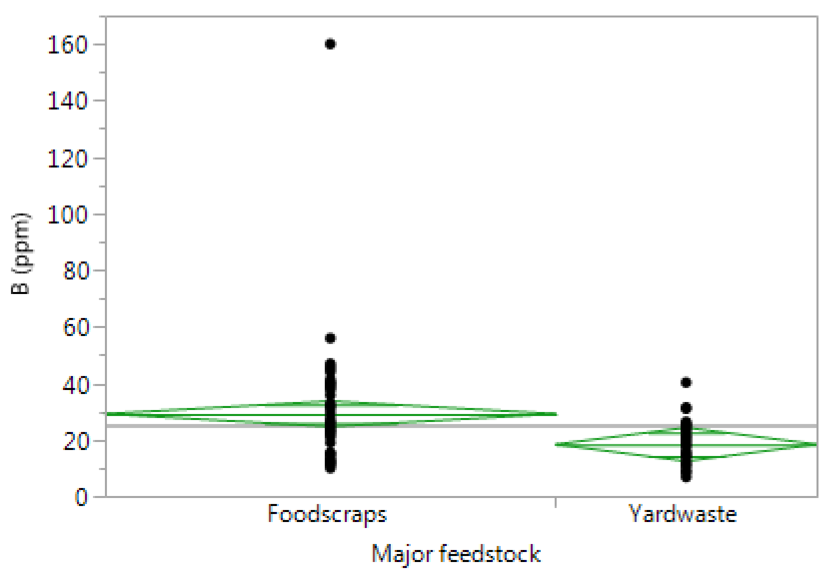
Cu (ppm) (n=299): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Separated Dairy	58	386.3^{A}	279.0	30.0	1076.0	437.4
Paper Residuals	8	75.3^{B}	21.1	47.7	112.0	73.6
Food scraps	60	62.3^{B}	28.1	25.8	150.0	50.7
Manure	15	57.8^{B}	18.6	26.1	89.4	61.8
Silage	5	56.7^{B}	28.6	28.2	100.4	47.3
Yard waste	51	54.0^{B}	80.5	11.1	516.6	34.7
Dairy	89	51.1^{B}	38.8	13.7	194.0	33.0
Poultry	31	47.6^{B}	37.2	12.8	183.6	41.0
Horse	3	29.1^{B}	3.4	26.5	33.0	27.9



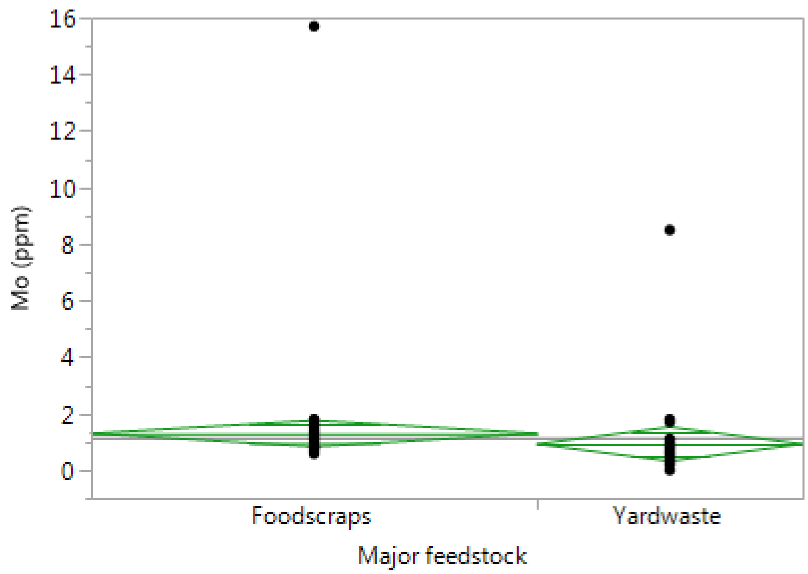
B (ppm) (n=90): Means with different superscripts are significantly different. p=0.0284

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Food scraps	57	29.2[A]	20.8	10.0	160.0	26.1
Yard waste	33	18.4[B]	7.5	6.8	40.3	16.2



Mo (ppm) (n=91): Means with different superscripts are significantly different. NS

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Food scraps	57	1.3[A]	2.0	0.6	15.7	0.9
Yard waste	34	0.9[A]	1.4	0.0	8.5	0.7

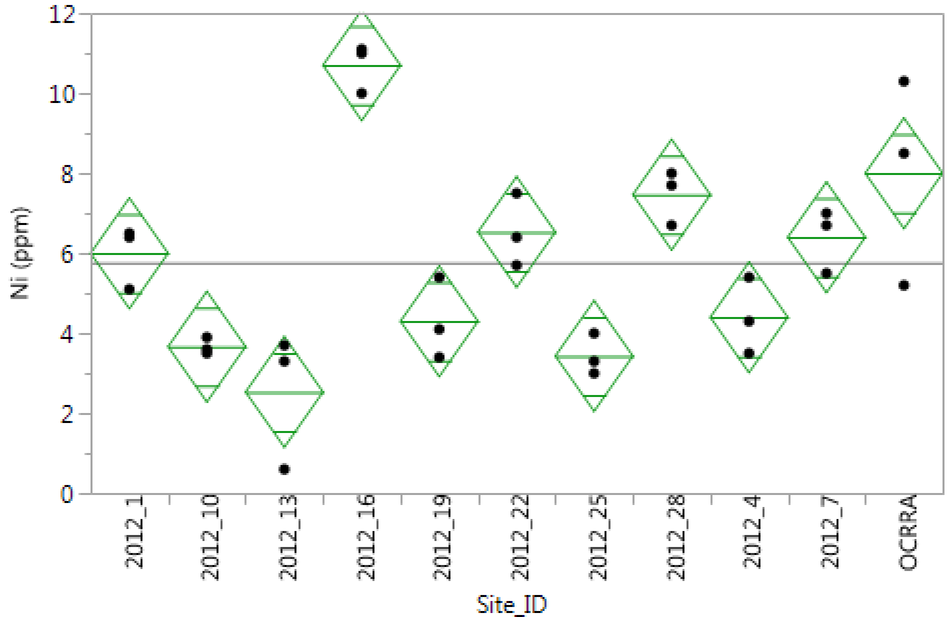


Ni (ppm) (n=33): Yard waste only from Leaf and Yard waste DEC sampling 2012

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Yard waste	33	5.8	2.5	0.6	11.1	5.4

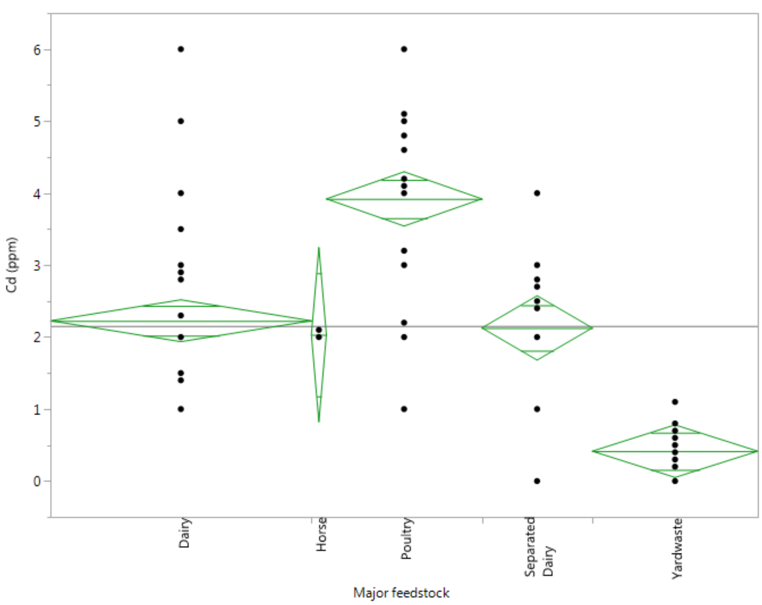
Ni (ppm) (n=33): Means with different superscripts are significantly different p<.0001

Site ID	N	Mean	Std. Dev.	Min	Max	Median
2012_16	3	10.7^{A}	0.6	10.0	11.1	11.0
OC yard waste	3	8.0^{B}	2.6	5.2	10.3	8.5
2012_28	3	7.5^{BC}	0.7	6.7	8	7.7
2012_22	3	6.5^{BC}	0.9	5.7	7.5	6.4
2012_7	3	6.4^{BC}	0.8	5.5	7.0	6.7
2012_1	3	6.0^{CD}	0.8	5.1	6.5	6.4
2012_4	3	4.4^{DE}	1.0	3.5	5.4	4.1
2012_19	3	4.3^{DE}	1.0	3.4	5.4	4.3
2012_10	3	3.7^{E}	0.2	3.5	3.9	3.6
2012_25	3	3.4^{E}	0.5	3.0	4.0	3.3
2012_13	3	2.5^{E}	1.7	0.6	3.7	3.3



Cd (ppm) (n=141): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Poultry	31	3.9^{A}	1.3	1.0	6.0	4.1
Dairy	52	2.2^{B}	1.1	1.0	6.0	2.0
Separated Dairy	22	2.1^{B}	1.3	0.0	4.0	2.0
Horse	3	2.0^{B}	0.1	2.0	2.1	2.0
Yard waste	33	0.4^{C}	0.2	0.0	1.1	0.4



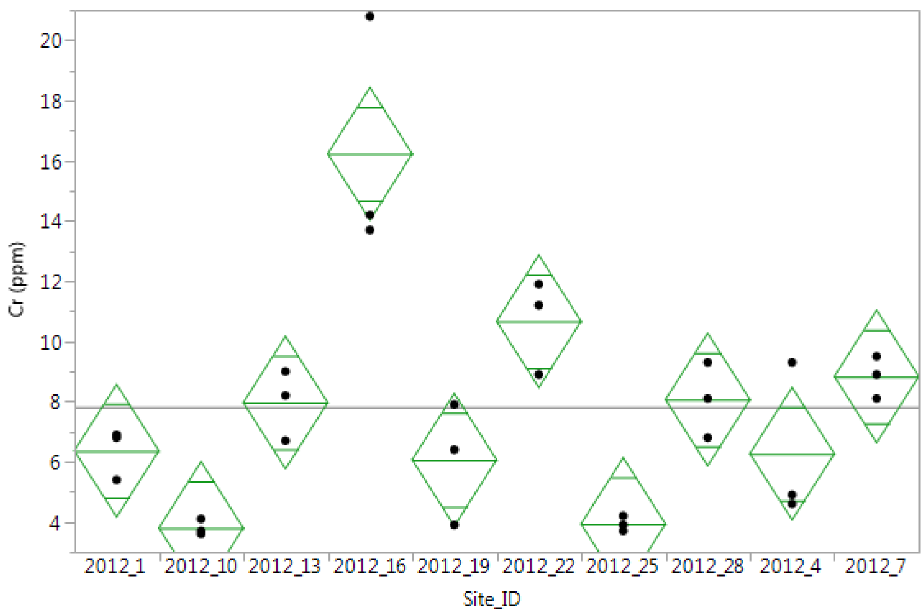
Cr (ppm) (n=30): Yard waste only from Leaf and Yard waste DEC sampling 2012

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Yard waste	30	7.8	3.8	3.6	20.8	7.4

Cr (ppm) (n=20): Means with different superscripts are significantly different p<.0001

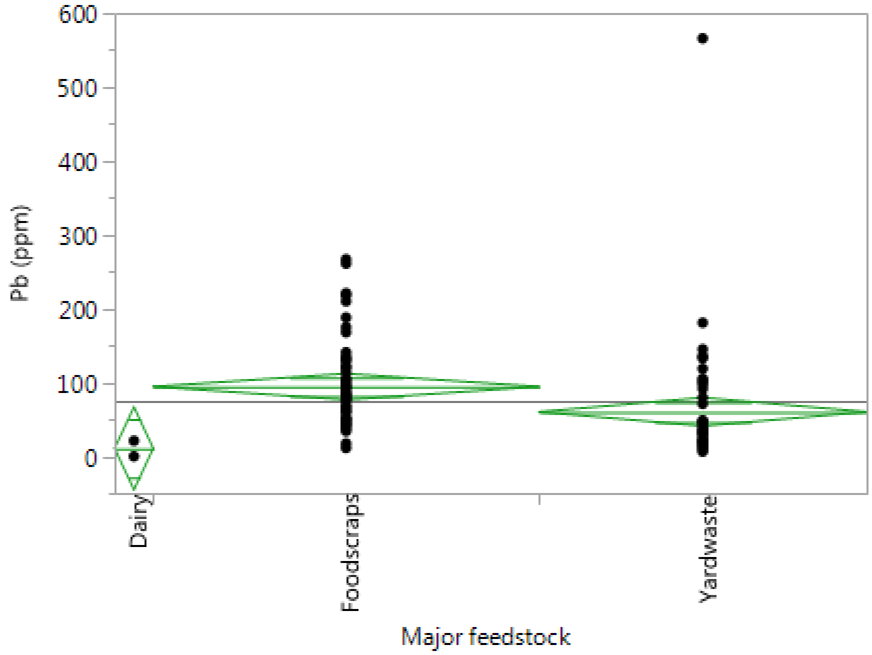
Site ID	N	Mean	Std. Dev.	Min	Max	Median

2012_16	3	16.2^A	4.0	13/7	20.8	14.2
2012_22	3	10.7^B	1.6	8.8	11.9	11.2
2012_7	3	8.8^BC	0.7	8.1	9.5	8.9
2012_28	3	8.1^BC	1.3	6.8	9.3	8.1
2012_13	3	8.0^BC	1.2	6.7	9.0	8.2
2012_1	3	6.4^CD	0.8	5.4	6.9	6.8
2012_4	3	6.3^CD	2.6	4.6	9.3	4.9
2012_19	3	6.1^CD	2.0	3.9	7.9	6.4
2012_25	3	3.9^D	0.3	3.7	4.2	3.9
2012_10	3	3.8^D	0.3	3.6	4.1	3.7



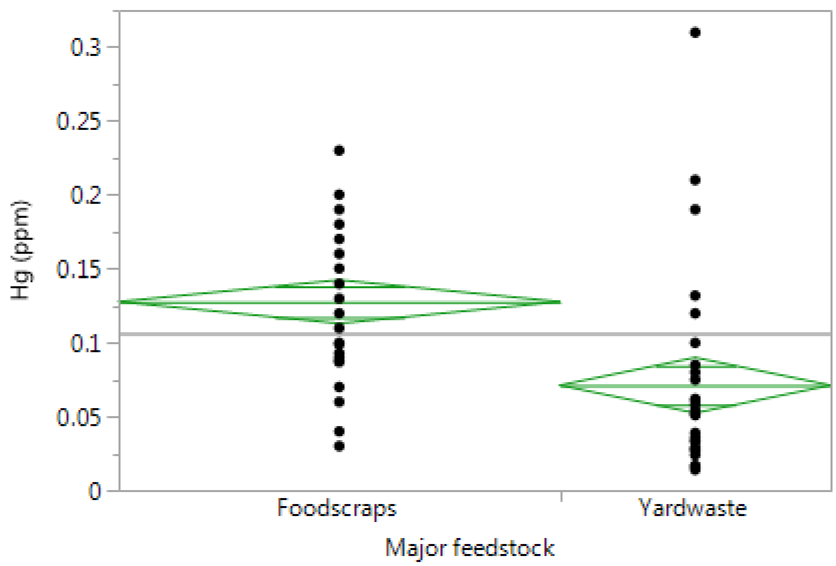
Pb (ppm) (n=117): Means with different superscripts are significantly different. p=0.0028

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Food scraps	60	94.4^A	58.0	11.3	267.0	84.1
Yard waste	51	60.3^B	83.4	6.5	566.0	35.4
Dairy	6	10.8^B	11.9	0.0	21.9	10.6


Pb (ppm)
600
500
400
300
200
100
0
Dairy
Foodscraps
Yardwaste
Major feedstock

Hg (ppm) (n=92): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Food scraps	57	0.13^{A}	0.04	0.03	0.23	0.12
Yard waste	35	0.07^{B}	0.07	0.01	0.31	0.05

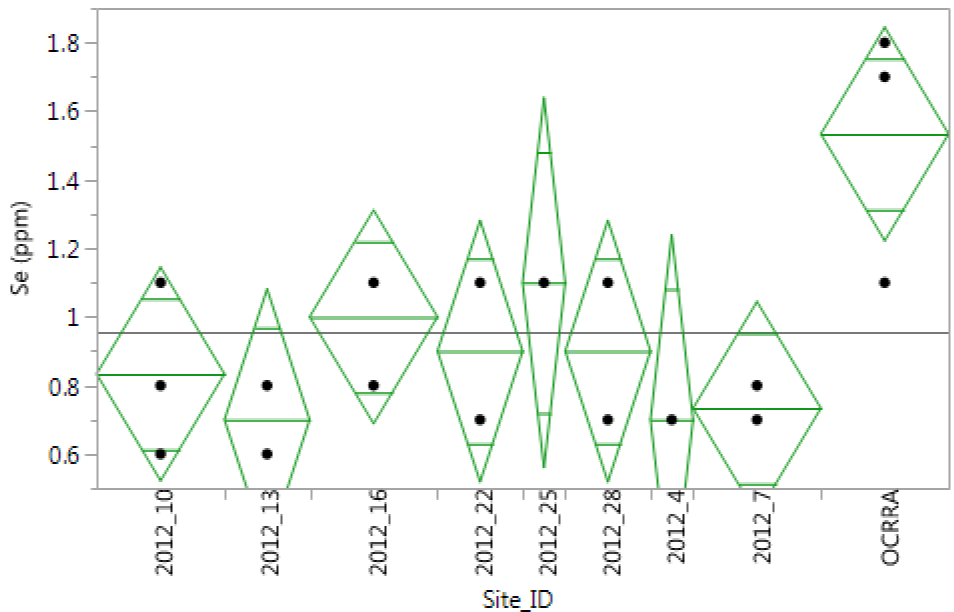


Se (ppm) (n=20): Yard waste only from Leaf and Yard waste DEC sampling 2012

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Yard waste	20	1.0	0.3	0.6	1.8	0.8

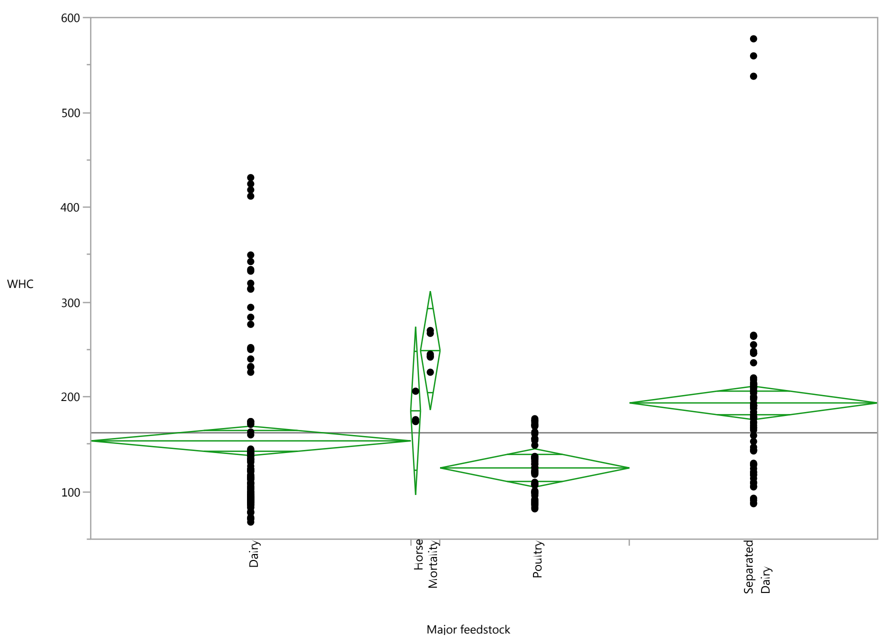
Se (ppm) (n=20): Means with different superscripts are significantly different p=0.0485

Site ID	N	Mean	Std. Dev.	Min	Max	Median
OC yard waste	3	1.5^{A}	0.4	1.1	1.8	1.7
2012_25	1	1.1^{AB}		1.1	1.1	1.1
2012_16	3	1.0^{B}	0.2	0.8	1.1	1.1
2012_22	2	0.9^{B}	0.3	0.7	1.1	0.9
2012_28	2	0.9^{B}	0.3	0.7	1.1	0.9
2012_10	3	0.8^{B}	0.3	0.6	1.1	0.8
2012_7	3	0.7^{B}	0.1	0.7	0.8	0.7
2012_13	2	0.7^{B}	0.1	0.6	0.8	0.7
2012_4	1	0.7^{B}		0.7	0.7	0.7



Water Holding Capacity (n=241): Means with different superscripts are significantly different. p<.0001

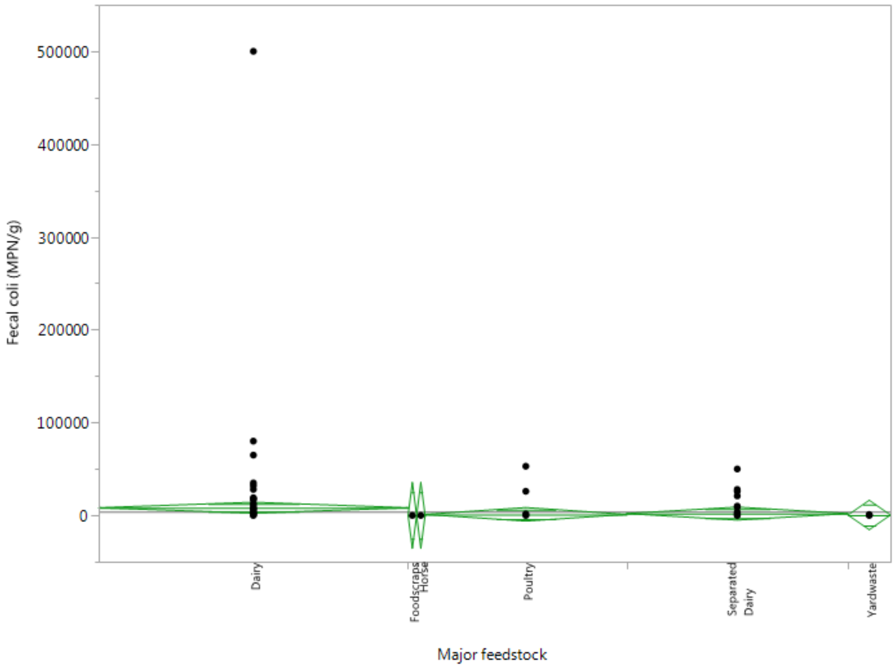
Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Mortality	6	248.8[A]	16.7	226.0	270.0	244.0
Separated Dairy	76	193.6[A]	88.1	87.4	577.6	189.0
Horse	3	185.3[ABC]	17.9	174.0	206.0	176.0
Dairy	98	153.6[B]	91.0	68.0	431.2	115.5
Poultry	58	125.1[C]	28.3	82.0	177.0	122.3



Fecal coliforms (MPN/g) (n=279): Means with different superscripts are significantly different. NS

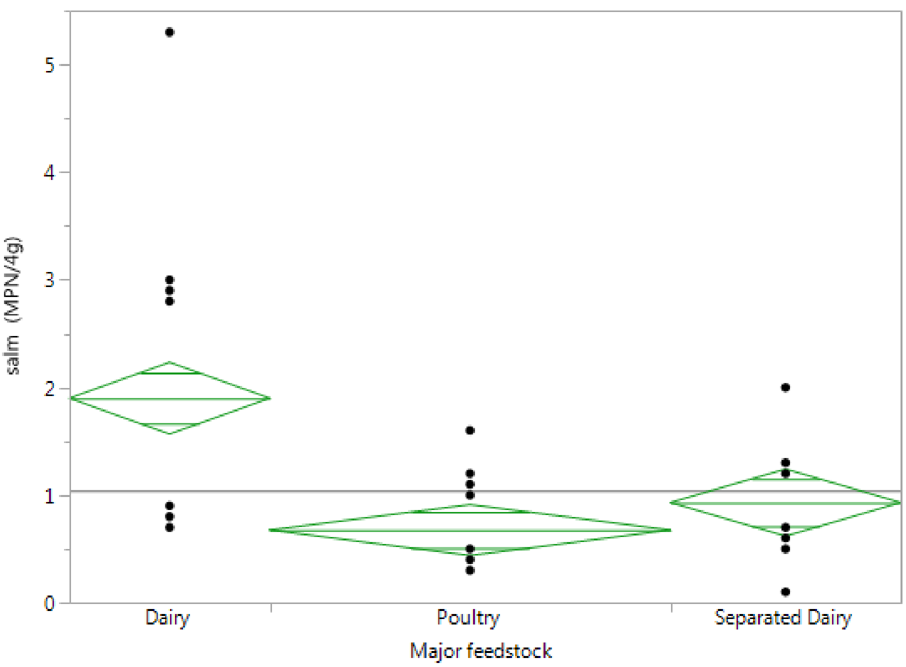
Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Dairy	109	8286.8	48894.2	1.0	500000.0	36.0
Separated Dairy	78	2018.5	7461.1	1.0	50001.0	11.5
Poultry	71	1144.5	6963.9	0.2	53000.0	2.7

Yard waste	15	438.8	648.7	0.0	1600.0	62.0
Food scraps	3	13.7	17.2	0.0	33.0	8.0
Horse	3	2.9	1.0	2.0	3.9	2.7



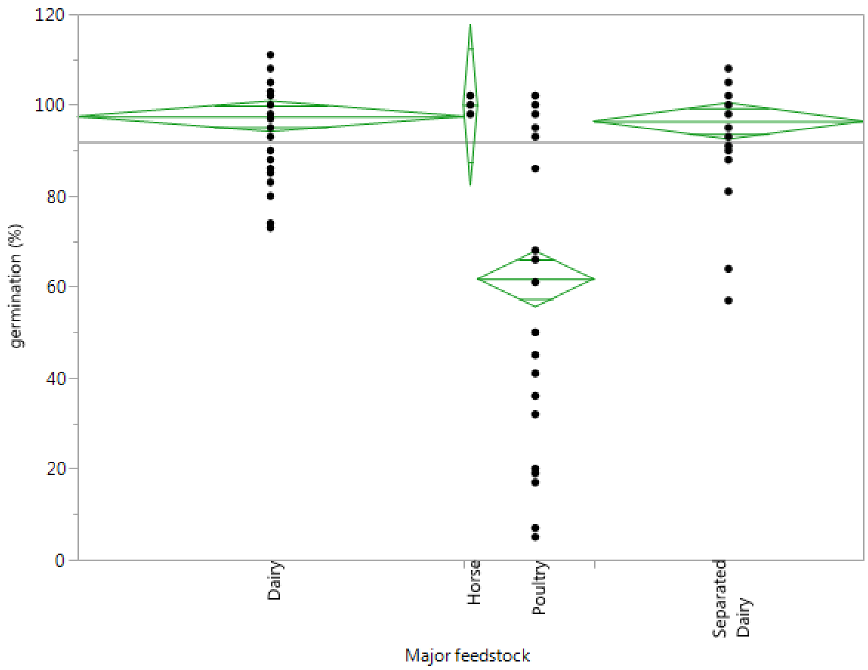
Salmonella (MPN/4g) (n=83): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Dairy	20	1.9^{A}	1.3	0.7	5.3	0.9
Separated Dairy	23	0.9^{B}	0.6	0.1	2.0	0.7
Poultry	40	0.7^{B}	0.4	0.3	1.6	0.5



% germination (n=332): Means with different superscripts are significantly different. p<.0001

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Horse	3	100.0[A]	2.0	98.0	102.0	100.0
Dairy	83	97.5[A]	6.9	73.0	111.1	100.0
Separated Dairy	58	96.4[A]	8.2	57.0	108.0	98.0
Poultry	25	61.8[B]	36.3	5.0	102.0	66.0



Germinable weeds (#/liter) (n=174): Means with different superscripts are significantly different. NS

Major Feedstock	N	Mean	Std. Dev.	Min	Max	Median
Poultry	31	23.0	40.6	0.0	105.0	0.0
Separated Dairy	57	11.9	37.0	0.0	227.0	0.0
Dairy	83	6.5	17.1	0.0	99.0	1.0
Horse	3	0.0	0.0	0.0	0.0	0.0